

UREDINALES OF COSTA RICA BASED ON COLLECTIONS BY E. W. D. HOLWAY

J. C. ARTHUR

A recent writer has said that "Costa Rica is an oasis of progress in that long reach of country which extends from the Rio Grande to the equator. It is the one Central American nation which has lifted itself fully out of the anarchy of mercenary revolutions and of semi-savage internal warfare and intrigue." The country is largely mountainous, and fully eighty per cent. of the inhabitants of the highlands are pure Caucasian, mainly of Spanish ancestry. Schools are abundant. The natural scenery of the country is surpassingly beautiful and the climate of the highlands agreeable.

The chief cities and best known mountain peaks lie along the tenth meridian of north latitude, and the only line of railroad, excepting two or three short spurs, extends along this meridian from Limón on the Atlantic side to Puntarenas on the Pacific side, a distance of about one hundred and seventy miles, or considerably less than from Detroit to Chicago. The two largest cities, San José, the capital, and Cartago, lie about half way from coast to coast, approximately on the eighty-fourth degree of west longitude, or directly south of Bay City, Michigan, or less accurately of Toledo, Ohio, and but twelve miles apart by rail, being on either side the continental divide at an elevation above the sea nearly the same as that of Denver, Colorado. The two highest volcanoes, Irazú, 11,000 feet, and Poás, 8,000 feet, sometimes active, present no difficulties in their ascent, except the tediousness of rough trails and the inconvenience of mists and frequent rains.

Owing to the primitive accommodations for travelers in small towns and the almost entire absence of good highways, only the immediate vicinity of the railway is likely to receive much attention from students of mycology and natural history in general for

some time to come, unless some intrepid explorer should chance to take a fancy to roughing it in Costa Rica.

The soil is exceedingly rich, and vegetation is luxuriant. On the Atlantic side the slope is gradual from the continental divide to a wide stretch of marsh and low land along the coast, and owing to the almost daily precipitation during every month in the year it is a nearly impenetrable jungle of forest and swamp. On the Pacific side of the divide the country is more mountainous, forming a plateau dropping rapidly on its western border to the Pacific coast, and with a well-marked dry season between November and April. This highland portion of the country has a moderate climate in which not only coffee, the staple crop, and other kinds of tropical vegetation flourish, but also potatoes, corn, cereals and most of the garden vegetables of the temperate zone. Under such conditions a native vegetation of extraordinary richness and diversity flourishes, which is allied somewhat more to that extending southward into South America than to that extending northward.

The only resident of Costa Rica who has paid attention to its fungous flora, so far as the writer knows, is Sr. Adolfo Tonduz, for many years associated with the Museo Nacional at San José. He is the author of a pamphlet on the coffee-leaf disease caused by a hyphomycete. In the following list he is credited with ten collections, most of which were transmitted to the writer by Dr. N. Patouillard, Neuilly-sur-Seine, France. He is an earnest student of the general flora of the country. Phanerogamic collections by him are to be found in many herbaria, and from three of these collections specimens of rusts have been taken.

Undoubtedly the best authority at present upon the higher plants of Costa Rica is Mr. Henry Pittier, now at the National Herbarium, Washington, D. C. He is the author of a botanical handbook of 176 pages (*Ensayo sobre las Plantas Usuales de Costa Rica*. 1908), and has contributed studies of the native flora to the "Contributions from the National Museum." Two collections of rusts by him are mentioned in the following list, both on the so-called Irish potato, as it is found growing wild on the upper slopes of the Volcán de Irazú.

In 1913 Mr. Ellsworth Bethel, of the State Museum, Denver, Colo., paid a brief visit to Costa Rica and contributed two specimens of rusts toward the present list. The collection of one rust is also credited to H. Polakowsky.

Aside from the above eighteen collections and one specimen contributed by the Royal Herbarium, Kew, England, the material which goes to make up the following account of the rusts of Costa Rica was supplied by Professor E. W. D. Holway, of the University of Minnesota. Of the 118 species in the list all are represented among his collections, except three that are reported solely by Sr. Tonduz. The 208 specimens in the Holway material were obtained during a trip to Costa Rica in the winter of 1915-16, made for the special purpose of collecting rusts. Professor Holway is an experienced and able collector. His home has been in Iowa and Minnesota, but he has traveled extensively and has searched for rusts not only in the United States and Canada, but also in various sections of Mexico, Guatemala, Panama and the West Indies.

Professor Holway entered Costa Rica at Limón on December 9, 1915, and proceeded at once to San José. His first impressions must have been of disappointment, judging from his brief letters to the author. On December 10 he writes: "Arrived last night. Costa Rica is too civilized, not near as interesting as Guatemala." Three days later he says: "This country has climate, but not much else—no Indians, no great native markets, absolutely no native manufacture except a crude large jar made by hand entirely. I mourn for Guatemala." Not only was he at first disappointed as a traveler in the lack of strangeness and picturesqueness, but also as a collector because long, tiresome walks must be taken to reach favorable surroundings for rusts. In the vicinity of the larger cities "every inch is pastured or used for coffee," as he says, "and the wild plants have no place to stay." But if his spirits at first were depressed by these unexpected evidences of material advancement and prosperity, they rose later as he became acquainted with the less conventional parts of the country. On January 9, 1916, he writes: "I am just in from Volcán de Poás. The 'rain-forest' on the summit is magnificent. I never

saw anything like it. Wonderful flowering trees and vines with enormous blooms, and of course epiphytes in great numbers. However, it began to rain as we reached the woods, and it blew fifty miles an hour. The trail, one to two feet deep in mud and water, was certainly fierce!"

After about six weeks in Costa Rica, which included a trip to the Pacific coast and an ascent of Volcán de Irazú, Professor Holway departed by way of Limón on January 23, 1916. The quantity of material secured was somewhat disappointing, partly due to the unfavorable season, but it was rich in interesting forms, every fifth species being new to science or else to North America. The general impression left by the experience could doubtless be expressed in the sentiment of the words with which the Calverts close their recent volume on "A year of Costa Rican natural history." They say: "Our most cherished dream is of returning to the Enchanted Land."

There is one rust which Professor Holway fortunately did not find. In the herbarium of the Missouri Botanical Garden there is a specimen labelled "Hemileia vastatrix, on coffee, Costa Rica, distributed in Tonduz' Enfermedad Cafetera, 1893." The small portion of this specimen, which the writer has been privileged to examine, yielded no rust, but did bear some other fungus. In December, 1915, I wrote to Professor Holway, who was then in Costa Rica, about this specimen, and at his suggestion enlisted the assistance of Mr. F. Nutter Cox, British Consul at San José, who is interested in coffee production, and has considerable botanical knowledge of the region. Mr. Cox transmitted a letter from Sr. A. Tonduz, of the date of May 8, 1916, who is now officially connected with the Department of Agriculture of Costa Rica, and considerably gave a translation from the Spanish original. The part of the latter which follows puts the matter very clearly.

"In 1893 my pamphlet on 'A coffee leaf disease' (Enfermedad del cafeto) was accompanied by dried leaves of coffee attacked by *Stilbum flavidum*, a fungous growth causing 'maya' or 'viruela,' the disease which formed the subject of the study or thesis. I do not know to whom it has occurred to label these

specimens *Hemileia vastatrix*, which are affected with 'maya,' a very common disease in San José. To my knowledge *Hemileia vastatrix** has not at any time invaded the American continent, its dependencies, or the West Indies."

Mr. Cox in his letter of May 12, 1916, says: "Evidently someone, not Tonduz, has blundered, and knowing by hearsay of *Hemileia vastatrix* as a coffee-leaf disease, has assumed that Tonduz' specimen leaves of a coffee-leaf disease were affected by the disease he or she had read about, i. e., *H. vastatrix*. I personally have never seen or heard of *H. vastatrix* in Costa Rica, nor known of anyone else who has, and there is not the slightest difficulty in recognizing it."

The coffee-leaf rust, *H. vastatrix*, doubtless does not occur in the western hemisphere at the present time. It was first admitted to the North American flora on the strength of a statement that it was once found in Porto Rico. It certainly does not exist there now, whatever truth may have been in the report, and has not recently been heard of from any other locality in either North or South America, or in the adjacent islands. The entries in the *North American Flora* (7:150. 1907), and in Sydow's *Monographia Uredinearum* (3:210. 1914), should be cancelled.

When the possibility was being considered that the coffee rust did occur in Central America, Professor Holway wrote under date of March 2, 1916, as follows: "The first two collections of the Inga rust [which I made in Costa Rica] were on young plants, four feet high, growing with coffee plants, one growing from the same spot as a coffee tree. The likeness in young specimens is remarkable—several natives saying at once that the Inga was coffee. Fresh, young shoots are practically identical. The importance of the rust prevented my being caught. I first found the taste quite different and later discovered a larger tree of Inga, in which the close resemblance disappears. It is evident that future reports of the occurrence of the coffee rust, not founded upon examination of the fungus, must be taken with caution."

This first presentation of 118 species of rusts for Costa Rica, here given, including 22 species new to science and 12 previously

known from South America but new to North America, besides many new hosts and much extension of range for numerous other species, is certainly a fine showing for a country whose width from ocean to ocean is not half the distance from Chicago to Detroit, and for an area covered by observation not equal to the State of Rhode Island. Doubtless a general exploration of the 23,000 square miles of territory embraced in Costa Rica will fully demonstrate the great richness and importance of its rust flora, as has been shown for certain flowering plants, insects, and other natural history groups, both plant and animal.

The study of the Costa Rican rusts has constituted a part of the preliminary work on the rust flora of North America being prosecuted as a special project at the Purdue Agricultural Experiment Station, Lafayette, Ind. Credit is due to the several members of the laboratory staff who during the last two years or more have assisted in the work.

Family: COLEOSPORIACEAE

1. COLEOSPORIUM IPOMOEAE (Schw.) Burr. (on *Convolvulaceae*)
Ipomoea purga Hayne, Orotina, Dec. 30, 1915, II, iii, 320.
Ipomoea sp., San José, Jan. 3, 1916, II, 358.

The species was also detected in the phanerogamic herbarium of the New York Botanical Garden, showing an abundance of uredinia and telia on *Pharbitis hederacea* (L.) Choisy (*I. hederacea* Roth.) collected at San José, January 1896, A. Tonduz 7090. The aecia occur on pine leaves, but have not been collected outside of the United States.

2. COLEOSPORIUM VIBURNI Arth. (on *Caprifoliaceae*)
Viburnum sp., Volcán de Irazú, Jan. 21, 1916, II, 451.

A very local species, rarely collected, extending northward as far as Wisconsin. The aecia have not yet been detected.

3. COLEOSPORIUM ELEPHANTOPODIS (Schw.) Thüm. (on
Carduaceae)
Elephantopus hypomalacus Blake, Orotina, Dec. 29, 1915, II, 314.
A common rust, whose aecia are unknown.

4. COLEOSPORIUM EUPATORII Arth. (on *Carduaceae*)

Eupatorium collinum DC., San José, Dec. 28, 1915, II, 311.

Eupatorium Oerstedianum Benth., San José, Dec. 10, 1915, II, 236, same, Jan. 3, 1916, II, 354; San Ramón, Jan. 12, 1916, II, 412.

A somewhat common species of Central America and the West Indies. The aecia are unknown.

5. COLEOSPORIUM VERBESINAE Diet. & Holw. (on *Carduaceae*)

Verbesina myriocephala Sch. Bip., San Ramón, Jan. 13, 1916, II, 415.

The species was also collected on *Verbesina nicaraguensis* Benth., at San José in 1911, and again at San Francisco de Guadalupe, Nov. 3, 1912, both by A. Tonduz, and both showing abundance of uredinia. The latter collection was distributed in Sydow, *Fungi exotici exsiccati* 115. Aecia are not known.

Family: UREDINACEAE (MELAMPSORACEAE)

6. CHRYSOCELIS LUPINI Lagerh. & Diet. (on *Fabaceae*)

Lupinus Clarkei Oerst., Volcán de Irazú near Cartago, Jan. 21, 1916, I, 454.

In most South American collections of this rust there are telia associated with the aecia. The aecial stage on the same host was also collected by E. Bethel, in about the same locality at 10,000 feet elevation, March 15, 1913, and also without trace of telia. This is the first report of the rust in North America.

7. CEROTELIUM FICI (Cast.) Arth. (on *Artocarpaceae*)

Ficus sp., San José, Dec. 10, 1915, II, 237½, 238.

A cosmopolitan rust of warm regions, but only uredinia have been found in America.

8. PHAKOPSORA VITIS (Thüm.) Syd. (on *Vitaceae*)

Vitis sp.

This widely distributed rust, especially on cultivated grapes, was collected in the uredinial stage on a cultivated grape at San

José, by A. Tonduz, date not given. A specimen was communicated by N. Patouillard.

9. SPIRECHINA RUBI (Diet. & Holw.) Arth. (on *Rosaceae*)
Rubus trichomallus Schlecht., San José, Dec. 11, 1915, II₁, ii₂,
254.

A very abundant species of Guatemala and Mexico, possessing pycnia, uredinia and telia.

10. SPIRECHINA LOESENERIANA (P. Henn.) Arth. (on *Rosaceae*)
Rubus trichomallus Schlecht., above El Alto near Cartago, Jan.
16, 1916, II₁, III, 435.

A long-cycle species, similar to *S. Rubi*, found chiefly in South America, and heretofore only once reported for North America, that being from Guatemala, collected in 1896.

11. SPIRECHINA PITTIERIANA (P. Henn.) Arth. (on *Rosaceae*)
Rubus adenotrichos Schlecht., slopes of Irazú above Cartago,
Dec. 23, 1915, O, II₁, 285.

Rubus sp., on road to Fraijanes, Volcán de Poás, Jan. 6, 1916,
O, II₁, III, 380; San José, Jan. 8, 1916, O, II₁, III, 393.

This rust was first described as *Uromyces Pittierianus* P. Henn., and at the same place (Hedw. Beibl. 41: 101. 1902) the uredinia were called *Uredo ochraceo-flavus* P. Henn., both names being founded on a collection by A. Tonduz, made at Hacienda Belmira near Santa María de Dota, January 1898, on *Rubus* sp., the host bearing the number 11615. Through the kindness of I. Urban, of the Bot. Museum of Berlin, I have been able to examine a portion of both types. By my suggestion Dr. Urban secured the determination of the host, Dr. W. O. Focke pronouncing it to be *R. adenotrichos*.

12. CRONARTIUM COLEOSPORIOIDES (Diet. & Holw.) Arth. (on
Scrophulariaceae)

Castilleja tenuiflora Benth. (?) Volcán de Irazú, Jan. 21, 1916,
II, iii, 452.

A common rust throughout the mountainous region of western North America. It has its aecia on twigs and trunks of pine, but they have not yet been taken in Mexico or Central America.

13. *CRONARTIUM WILSONIANUM* Arth. (on *Vitaceae*)

Cissus rhombifolia Vahl (?), slopes of Irazú above Cartago, Dec. 23, 1915, II, 286; Orotina, Dec. 30, 1915, III, 323; same, Dec. 31, 1915, II, 345.

A long-cycle rust, heretofore known only from Cuba. The alternate form is still undetected. The specific determination of the host for each of the three collections is very uncertain.

14. *CIONOTHRIX PRAELONGA* (Wint.) Arth. (on *Carduaceae*)

Eupatorium daleoides (DC.) Hemsl., Trail to Volcán de Poás, Jan. 5, 1916, 367; Cartago, Jan. 20, 1916, 448a.

Eupatorium odoratum L., Orotina, Dec. 30, 1915, 321.

Eupatorium sp., San José, Dec. 27, 1915, 306.

This short-cycle rust was also detected in the phanerogamic herbarium of the N. Y. Bot. Garden, on *E. daleoides* Hemsl., Forets du Copey, February 1898, Tonduz 11679.

15. *ALVEOLARIA CORDIAE* Lagerh. (on *Ehretiaceae*)

Cordia ferruginea R. & S., San Ramón, Jan. 13, 1916, 414.

A peculiar, short-cycle rust, occurring also in Guatemala and the West Indies, as well as in South America. The host is a new one.

Family: AECIDIACEAE (PUCCINIACEAE)

16. *RAVENELIA INGAE* (P. Henn.) Arth. (on *Mimosaceae*)

Inga leptopoda Benth., San José, Jan. 8, 1916, O, II₁, II₂, 389; same, Jan. 10, 1916, O, II₁, 400; Tres Rios near San José, Jan. 17, 1916, II₂, 436.

Inga sp., San José, Dec. 26, 1915, O, II₁, 295.

A common rust on many species of *Inga* in tropical America, and like all species of the genus doubtless possesses pycnia, uredinia, and telia, although the telia have not yet been seen.

17. *RAVENELIA MIMOSAE-ALBIDAE* Diet. (on *Mimosaceae*)
Mimosa albida H.B.K., San José, Dec. 27, 1915, II₂, 302.

The species is also known from Guatemala and Mexico.

18. *Ravenelia ectypa* Arthur & Holway sp. nov. (on
Mimosaceae)

Calliandra gracilis Klotsch, San José, Dec. 26, 1915, II, III, 296.

Uredinia amphigenous, scattered or somewhat grouped, round, 0.5–1 mm. across, early naked, subcuticular, pulverulent, cinnamon-brown, ruptured cuticle evident; paraphyses none; urediniospores broadly ellipsoid or obovoid, 17–19 by 19–26 μ ; wall golden-brown, uniformly thin, 1 μ , moderately echinulate, the pores 6 or 7, scattered.

Telia amphigenous, scattered, round, 0.4–1 mm. across, early naked, subcuticular, dark chestnut-brown, ruptured cuticle evident; teliospore-heads hemispherical, usually consisting of four central and six marginal spores, 42–60 μ in diameter, each spore bearing 4–12 light brown spines, 3–5 μ long; cysts attached to the lower side of the marginal spores.

This species approaches *R. echinata* Lagerh. & Diet., but has larger urediniospores and smaller teliospore-heads. In *R. echinata* the heads have 6 central and 8 marginal spores, while in this species there are 4 central and 6 marginal spores.

19. *RAVENELIA HUMPHREYANA* P. Henn. (on *Caesalpinaceae*)
Poinciana pulcherrima L., Orotina, Dec. 30, 1915, II₂, 328.

A common long-cycle rust of the West Indies, Guatemala and Mexico.

20. *CALLIOSPORA DIPHYSAE* Arth. (on *Fabaceae*)

Diphysa robinoides Benth., Heredia, Dec. 17, 1915, O, III, 270;
San José, Dec. 28, 1915, O, III, 310.

Diphysa sp., Orotina, Dec. 31, 1915, O, III, 336.

Heretofore this short-cycle rust has been known from Mexico and Guatemala.

21. *PROSPODIUM APPENDICULATUM* (Wint.) Arth. (on
Bignoniaceae)

Stenolobium Stans (L.) D. Don (*Tecoma Stans* Juss.), San José, Dec. 28, 1915, III, 300.

A common warm-region rust in America. Like other species of the genus, it possesses pycnia, uredinia and telia.

22. PROSPIDIUM AMPHILOPHII (Diet. & Holw.) Arth. (on
Bignoniaceae)

Pithecoctenium muricatum DC., San José, Dec. 26, 1915, II, III, 293B; Orotina, Dec. 31, 1915, II, III, 334.

The species has heretofore been known only from Mexico.

23. PROSPIDIUM TUBERCULATUM (Speg.) Arth. (on *Verbenaceae*)
Lantana Camara L., Cartago, Dec. 22, 1915, II, 277.

The species is known in the tropical parts of both North and South America.

24. PROSPIDIUM LIPPIAE (Speg.) Arth. (on *Verbenaceae*)
Lippia myriocephala Schl. & Cham., road to Volcán de Poás,
Jan. 5, 1916, II, III, 372.
Lippia sp., San José, Jan. 3, 1916, II, III, 364; San Ramón, Jan.
13, 1916, II, 417.

The spores in this material are somewhat smaller and less strongly developed than usual. A common species in tropical America.

25. SPHENOSPORA PALLIDA (Wint.) Diet. (on *Smilacaceae*)
Smilax sp., San José, Dec. 26, 1915, II, 291.

An interesting rust, occurring also in South America, is now first reported for North America. The initial stage is unknown.

The genus *Sphenospora* was established by Dietel (Ber. Deut. Bot. Ges. 10: 63. 1892) to include the *Diorchidium pallidum* Wint. (*Grevillea* 15: 86. 1887). He speaks of the rust as on *Dioscorea*, although Winter in his original description, does not mention a name for the host, and neither is one mentioned in the later writings by Dietel (Engler & Prantl, Pfl. Fam. 11*: 70. 1897) or by Sydow, who calls it *Puccinia sphenospora* Syd., the host being spoken of as an unknown climbing plant. So far as the writer knows only one collection has heretofore been known, that made near Sao Francisco, Brazil, by Ule 143. The collec-

tion by Prof. Holway is quite ample, but no flowers or fruit were obtained. There seems little question, nevertheless, that the host is some species of *Smilax*.

26. UROMYCES ERAGROSTIDIS Tracy (on *Poaceae*)

Eragrostis limbata Fourn., Cartago, Dec. 14, 1915, II, iii, 255;
San Ramón, Jan. 13, 1916, II, 421.

A rust of wide distribution in America, its aecia being unknown.

27. UROMYCES COMMELINAE (Speg.) Cooke (on *Commelinaceae*)

Commelina longicaulis Jacq. (*C. nudiflora* Auct. not L.), Heredia,
Dec. 17, 1915, II, 261.

A common long-cycle rust in warmer regions, which rarely produces telia, and whose initial stage is unknown.

28. UROMYCES CELOSIAE Diet. & Holw. (on *Amaranthaceae*)

Iresine calea (Ibanez) Standley, San José, Dec. 10, 1915, II,
237; Tres Rios near San José, Jan. 17, 1916, II, III, 437.

A long-cycle rust occurring also in Guatemala, Mexico, and Cuba, whose first stage is unknown.

29. UROMYCES APPENDICULATUS (Pers.) Fries (on *Fabaceae*)

Phaseolus truxillensis H.B.K., San José, Jan. 10, 1916, II, 397.

This is a record of a new host for this cosmopolitan long-cycle rust. The species was also collected on a cultivated species of *Phaseolus* at Guadalupe near San José, Sept. 1908, II, and communicated by N. Patouillard, name of collector not given, but probably A. Tonduz.

30. UROMYCES MEXICANUS Diet. & Holw. (on *Fabaceae*)

Meibomia uncinata (DC.) Kuntze (*Desmodium uncinatum* DC.), San José, Jan. 18, 1916, II, III, 443.

Meibomia sp., San José, Jan. 17, 1916, II, III, 439.

A long-cycle species, the initial stage unknown, heretofore only reported from Mexico.

31. UROMYCES DECORATUS Syd. (on *Fabaceae*)

Crotalaria vitellina Ker., San José, Dec. 10, 1915, II, 246; same, Jan. 11, 1916, II, 410.

This long-cycle rust is now reported from America for the first time, having been previously known only from the East Indies. The uredinial sorus is applanate and nonparaphysate, being quite unlike that of *Phakopsora Crotalariae* (Diet.) Arth. The Costa Rican material compares exactly with Sydow, Uredineen 2151, on *C. juncea* from India, the type collection, but in the specimen seen showing only uredinia. Telia have not been seen. There is an *Uredo Theresae* Neg. (Beih. Bot. Centr. 13: 78. 1902), from Colombia, S. A., which may be the same, but no specimen has been seen and the description is inadequate for decision. There is also an *Aecidium crotalariicola* P. Henn. (Hedw. Beibl. 38: 70. 1899), from Brazil, which may possibly have genetic connection with this species, but no sufficient present information is available.

32. UROMYCES INDIGOFAERAE Diet. & Holw. (on *Fabaceae*)

Indigofera mucronata Spreng., Orotina, Dec. 30, 1915, II, 322.

A long-cycle rust, whose initial stage is not known. It extends northward into Texas.

33. UROMYCES GUATEMALENSIS Vesterg. (on *Fabaceae*)

Bauhinia inermis Pers., Orotina, alt. 600 feet, Dec. 29, 1915, ii, III, 315.

A collection on the same host, as well as the type collection of the species, with which this collection has been compared, came from Guatemala. The rust is a long-cycle one, whose initial stage is unknown.

34. UROMYCES COLOGANIAE Arth. (on *Fabaceae*)

Cologania pulchella H.B.K., San José, Dec. 10, 1915, II, 248.

Cologania sp., Road to Fraijanes on Volcán de Poás, Jan. 6, 1916, II, 381.

A long-cycle species reported from Mexico, Guatemala, and Porto Rico. The initial stage in the life cycle is unknown.

35. *UROMYCES PROËMINENS* (DC.) Pass. (on *Euphorbiaceae*)
Chamaesyce hypericifolia (L.) Millsp., Orotina, Dec. 29, 1915,
 II, III, 319.

Chamaesyce sp., Alajuela, Jan. 7, 1916, II, III, 384.

An autoecious, long-cycle rust, widely distributed over the earth, and quite variable in morphological characters.

36. *UROMYCES MYRSINES* Diet. (on *Myrsinaceae*)

Ardisia compressa H.B.K., south of Cartago, Dec. 22, 1915, III, 280.

A short-cycle rust of distinctive gross appearance, known on species of *Myrsine* from Bolivia and Brazil. This is the first record for North America. It is quite possible that *Uromyces marginatus* Bomm. & Rouss. (Bull. Soc. Bot. Belg. for 1896, page 156) may be synonymous with this species. It was described on an undetermined subcoriaceous leaf from Costa Rica, of which no material has been seen by the writer.

37. *Uromyces maculans* (Pat.) comb. nov. (on *Solanaceae*)
Cestrum nocturnum L.

The present record is founded on a collection made at Guadalupe near San José, March, 1909, by A. Tonduz, and communicated to the writer by N. Patouillard. It was on this collection that Patouillard founded the name *U. Cestri* var. *maculans* Pat. (Bull. Soc. Myc. Fr. 28: 140. 1912). It differs from *U. Cestri* in the more globoid and somewhat smaller aeciospores, as well as in the much thinner-walled teliospores. *Uromyces venustus* Diet. & Holw., of Mexico, has a rostrate teliospore, while *U. cestricola* Speg., of South America, has the peridial cells so finely verrucose as to appear smooth. From the three forms on *Cestrum* already recognized as species, this one appears abundantly different, and worthy of specific recognition. All of them are aeciogyrinious, and produce no urediniospores. They may be thus distinguished:

Telia	{	Teliospores rostrate	<i>U. venustus</i>
		Teliospores rounded or obtuse	
		Teliospore-wall thin (1.5-2.5 μ)	<i>U. maculans</i>
		Teliospore-wall thick (2.5-5 μ)	
		Teliospores largely ellipsoid	<i>U. Cestri</i>
		Teliospores largely globoid	<i>U. cestricola</i>

Aecia	{	Aeciospores largely globoid (18-26 by 24-29 μ)	
		Peridial cells long (48-67 μ) <i>U. venustus</i>
		Peridial cells short (24-42 μ) <i>U. maculans</i>
		Aeciospores largely oblong (19-26 by 25-37 μ)	
		Peridial cells distinctly verrucose <i>U. Cestri</i>
		Peridial cells appearing smooth <i>U. cestricola</i>

38. **Uromyces Hariotanus** Lagerh. sp. nov. (on *Acanthaceae*)
Thyrsacanthus strictus Nees (?), San Ramón, Jan. 13, 1916,
 III, 416; Tres Rios near Cartago, Jan. 17, 1916, III, 440.

These collections agree exactly, even to the appearance of the host, with a collection made by G. von Lagerheim, on *Acanthaceae*, obtained at Guamampata, Prov. Chimborazo, Ecuador, August, 1891, and distributed by the collector under the name of "*Uromyces Hariotanus* Lagerh. n. sp." The name does not appear to have been published. A description is therefore appended, using the Ecuadorian collection as the type, and retaining the name, given by the collector in honor of the distinguished mycologist of the Museum of Natural History, Paris, recently deceased.

Telia amphigenous, numerous, scattered, or sometimes crowded, usually round, 0.2-1 mm. across, early naked, pulverulent, chocolate-brown, ruptured epidermis evident; teliospores ellipsoid, 19-21 by 26-32 μ , rounded or obtuse at both ends; wall dark cinnamon-brown, thick, 3-4 μ , thickened into a light brown or colorless umbo at apex, 6-9 μ , closely to moderately and noticeably verrucose; pedicel colorless, one and a half times length of spore, fragile.

39. **UROMYCES HELLERIANUS** Arth. (on *Cucurbitaceae*)
Cayaponia attenuata Cogn., San José, Jan. 10, 1916, ii, III, 399.
 A long-cycle species, not uncommon in tropical North America, of which the initial stage is unknown.

40. **Uromyces pressus** Arthur & Holway sp. nov. (on
Carduaceae)
Vernonia Deppeana Less., San José, Jan. 3, 1916, II, iii, 361
 (type); El Alto near Cartago, Jan. 16, 1916, II, 432; Car-
 tago, Jan. 20, 1916, II, 450.
Vernonia sp., San Ramón, Jan. 13, 1916, II, III, 413.

Pycnia epiphyllous, inconspicuous, subepidermal, globoid, $110\ \mu$ in diameter; ostiolar filaments present.

Uredinia amphigenous, gregarious on discolored spots 1–3 mm. in diameter, oval or oblong, 0.2–0.4 mm. long, early naked, pulverulent, yellowish-brown, ruptured epidermis conspicuous; urediniospores obovoid or globoid, 23–26 by $26\text{--}32\ \mu$; wall yellowish or pale cinnamon-brown, thick, $2.5\text{--}3.5\ \mu$, moderately and rather coarsely echinulate, the pores 3, approximately equatorial.

Telia amphigenous, scattered, oval or oblong, 0.2–0.3 mm. long, early naked, white, ruptured epidermis usually inconspicuous; teliospores oblong-ellipsoid, or fusiform-ellipsoid, 16–18 by $29\text{--}35\ \mu$, rounded or somewhat narrowed at both ends; wall colorless, uniformly very thin, $0.5\ \mu$, smooth; pedicel colorless, about one half length of spore.

The pycnia were found sparingly on a specimen collected at Guagas, Ecuador, on *Vernonia* sp., December 1890, *G. Lagerheim*. The telia are very inconspicuous, due to their lack of color and early germination *in situ*.

41. *UROMYCES COLUMBIANUS* Mayor (on *Carduaceae*)

Melanthera aspera (Jacq.) Steud., Orotina, Dec. 29, 1915, II, iii, 318; San José, Jan. 8, 1916, O, I, II, 386.

Melanthera sp., Trail to Volcán de Poás, Jan. 5, 1916, I, II, III, 371; San Ramón, Jan. 14, 1916, II, 428.

A long-cycle rust common on species of *Melanthera* in tropical America, including the West Indies.

42. *UROMYCES BIDENTICOLA* (P. Henn.) Arth. (on *Carduaceae*)

Bidens tereticaulis antiguensis (Coul.) O. E. Schultz, Volcán de Irazú, Jan. 21, 1916, O, II, 453.

Bidens sp., Trail to Volcán de Poás, Jan. 5, 1916, O, II, 370.

These collections show pycnia and primary uredinia. The status of the name is given in *Mycologia* 9: 71. 1917.

43. *UROMYCES BIDENTIS* Lagerh. (on *Carduaceae*)

Bidens sp., San José, Jan. 8, 1916, 391 (with some leaves bearing *U. bidenticola* (P. Henn.) Arth.)

This correlated, short-cycle species is frequently associated with the preceding long-cycle species, and has about the same range.

44. **Uromyces Montanoae** Arthur & Holway sp. nov. (on *Carduaceae*)

Montanoa dunicola Klatt., San José, Dec. 11, 1915, II, III, 251; same, Jan. 18, 1916, II, 444; Tres Rios near San José, Dec. 20, 1915, II, 273.

Montanoa sp., San José, Jan. 3, 1916, II, 355; San Ramón, Jan. 14, 1916, II, 427.

Uredinia hypophyllous, scattered, round or oblong, 0.1–1 mm. across, early naked, pulverulent, cinnamon- or light chestnut-brown, ruptured epidermis evident; urediniospores when viewed with pores in optical section obovoid-triangular, 23–24 by 23–28 μ , with pores in central part obovoid or ellipsoid, narrower, 19–23 by 23–28 μ ; wall cinnamon-brown, thin, 1–1.5 μ , moderately echinulate, the pores 2, equatorial.

Telia hypophyllous, scattered, round, 0.3–0.5 mm. across, early naked, compact, dark cinnamon-brown, becoming cinereous from germination, ruptured epidermis inconspicuous; teliospores narrowly obovoid or ovoid, 18–21 by 29–40 μ , rounded at both ends or narrowed below; wall cinnamon-brown, thin, 1 μ , much thicker above, 4–7 μ , smooth; pedicel colorless or yellowish, as long as or shorter than the spore.

The species much resembles *Uromyces bidenticola*, but differs in having urediniospores with thinner walls, equatorial pores, and triangular form in certain positions. The teliospores often germinate at maturity, even in evident genetic connection with the uredinia. It is possible the same thing may occur in *U. bidenticola*.

The type for the species is a collection made by Professor Holway on *Montanoa Pittieri* Robs. & Greenm., in Guatemala, at San Lucas Toliman, 5100 feet alt., Dept. Solola, Feb. 2, 1915, II, III, 176.

45. **UROMYCES CUCULLATUS** Sydow (on *Carduaceae*)

Zexmenia aurantiaca Klatt.

The species, which is common in Mexico on a variety of hosts, was founded on a Costa Rican specimen sent to Sydow by Neger, which appears to have been taken from a phanerogamic collection made by A. Tonduz at Rio Visilla, Prov. San José, alt. 1,100 meters, represented in the herbarium Nat. Cost. 9836. A speci-

men in the Field Museum, Chicago, numbered 76850, appears to be part of the original Tonduz collection, and from this specimen, which shows well-developed telia, was taken the mycological material on which this entry is based.

46. PUCCINIA DOCHMIA Berk. & Curt. (on *Poaceae*)

Muhlenbergia tenella (H.B.K.) Trin., Cartago, Dec. 14, 1915, II, III, 256; San José, Dec. 27, 1915, ii, III, 304; same, Jan. 11, 1916, ii, III, 408.

This heteroecious rust, whose aecia are not known, was also collected on the same host in the telial stage, at San Juan, by H. Polakowsky, Dec. 1, 1875.

47. PUCCINIA CENCHRI Diet. & Holw. (on *Poaceae*)

Cenchrus echinatus L., Orotina, Dec. 31, 1915, II, 342.

A heteroecious rust, common in the warmer parts of America, whose aecia are unknown.

48. *Puccinia venustula* (Arth.) comb. nov. (on *Poaceae*)

Andropogon brevifolius Sw., Orotina, Dec. 29, 1915, II, III, 317.

Heretofore only one collection of this species has been known, the type collection for *Uredo venustula* Arth., on the same host, made by Prof. F. L. Stevens in Porto Rico (Mycol. 8: 21. 1916). The present collection shows abundance of telia in addition to the uredinia. The telial stage may be thus characterized.

Telia chiefly hypophyllous, scattered, oblong to linear, 0.2–1.0 mm. long, early naked, compact, blackish, ruptured epidermis evident, teliospores clavate or ellipsoid, 19–23 by 39–50 μ , rounded at both ends, or narrowed below; wall chestnut-brown below, chocolate-brown above, 2–3 μ , thickened above, 9–10 μ , smooth; pedicel short, chestnut-brown.

49. PUCCINIA PURPUREA Cooke (on *Poaceae*)

Sorghum sp. (cultivated).

A specimen of this rust was communicated by N. Patouillard, collected by A. Tonduz at Guadalupe, October, 1908, showing much parasitized uredinia. It is common and abundant on the cultivated sorghums in the tropics of both hemispheres.

50. *Puccinia canaliculata* (Schw.) Farl. (on *Cyperaceae*)
Cyperus ferax L. C. Rich., San José, Jan. 8, 1916, II, 385.
Dichromena radicans Schl. & Cham., San Ramón, Jan. 13, 1916,
II, 420.

A widespread heteroecious rust, usually only producing uredinia in the warmer regions.

51. *Puccinia consobrina* Arthur & Holway sp. nov. (on
Cyperaceae)

Rynchospora polyphylla Vahl, San Ramón, Jan. 14, 1916, II, III,
430.

II. Uredinia hypophyllous, scattered, oblong, 0.2–0.4 mm. long, soon naked, cinnamon-brown, ruptured epidermis noticeable; urediniospores globose or ellipsoid, 18–23 by 21–26 μ ; wall cinnamon-brown, 1.5–2.5 μ , moderately echinulate, the pores 2, equatorial.

III. Telia hypophyllous, scattered, ellipsoid, small, 0.1–0.2 mm. long, soon naked, chestnut-brown, ruptured epidermis inconspicuous; teliospores ellipsoid or oblong, 19–23 by 32–37 μ , rounded at both ends, somewhat constricted at septum; wall chestnut-brown, 2–3 μ thick, somewhat thicker above, about 7 μ including a lighter umbo; pedicel colorless, once to twice length of spore.

The species differs widely in its ellipsoid teliospores from *P. angustatoides* Stone, with its cuneate teliospores and occurring on various species of *Rynchospora* in the southeastern United States and the West Indies. The urediniospores also show differences in size and position of pores.

The rust occurs on the same host on a specimen in the phanerogamic herbarium of the N. Y. Bot. Garden, collected at Content Gap, vicinity of Cinchona, Jamaica, W. I., Sept. 2–10, 1906, II, III, *N. L. Britton* 33. Another collection from Jamaica has also been found in the cryptogamic collection of the same institution, on *R. corymbosa* (L.) Britton, road between Port Antonio and St. Margaret's Bay, March 28, 1913, II, *L. M. Underwood* 1715.

52. *Puccinia pallor* Arthur & Holway sp. nov. (on
Amaryllidaceae)

Bomaria sp., Volcán de Irazú, Cartago, Dec. 23, 1915, II, 287.

Pycnia amphigenous, crowded in small groups, noticeable, sub-epidermal, globose or slightly flattened, 96–160 μ in diameter.

Aecia amphigenous surrounding the pycnia, rather inconspicuous, 0.2–0.4 mm. in diameter, deep-seated, over-arched by two or more layers of host cells which tardily rupture by a short slit or pore; peridium wanting, but sometimes replaced by a thin layer of mycelium; aeciospores globose to broadly ellipsoid, 18–23 by 19–24 μ ; wall colorless, thin, 1–1.5 μ , closely and finely verrucose.

Uredinia hypophyllous, scattered, oval or oblong, 0.4–1 mm. long, rather tardily naked, at first opening by a slit or pore, pulverulent, yellowish, ruptured epidermis conspicuous; urediniospores broadly ellipsoid or obovoid, 18–21 by 23–28 μ ; wall colorless, thin, 1–1.5 μ , finely and closely echinulate, the pores obscure.

Telia hypophyllous, scattered, oval or oblong, 0.3–0.8 mm. long, rather early naked, somewhat pulverulent, white, ruptured epidermis evident; teliospores oblong to fusiform-oblong, 16–23 by 42–64 μ , rounded or acute at both ends, or sometimes narrowed below, slightly constricted at septum, germinating at maturity; wall colorless, thin, 1 μ , sometimes thickened at apex or side, 3–4 μ , smooth; pedicel colorless, somewhat fragile, half length of spore or less.

A very distinct species with *Eriosporangium*-like characters, the first such species to be found on monocotyledonous hosts. The aecia are easily overlooked. The type selected is a collection on *B. acutifolia* Herb. made by Professor Holway in Guatemala, Volcán de Agua, Dept. Sacatepéquez, March 7, 1916, O, I, II, III, 562.

53. PUCCINIA POLYGONI-AMPHIBII Pers. (on *Polygonaceae*)
Persicaria punctata (Ell.) Small (*Polygonum punctatum* Ell.),
San José, Jan. 8, 1916, II, 395.

A widespread species, only forming uredinia as a rule in the tropics.

54. *Puccinia detonsa* Arthur & Holway sp. nov. (on
Caryophyllaceae)

Stellaria ovata Willd., San José, Dec. 11, 1915, 252.

Telia hypophyllous and cauliculous, more or less confluent in round or elongate masses 1–2 mm. across on indefinite discolored

areas, or sometimes scattered, round, 0.3–0.6 mm. in diameter, early naked, pulvinate, light yellowish-brown, ruptured epidermis inconspicuous; teliospores oblong or fusiform-oblong, 12–15 by 30–40 μ , rounded or acute at apex, more or less narrowed below, somewhat constricted at septum; wall pale golden-brown, very thin, 1 μ or less, not or a little thickened above, up to 3 μ , smooth; pedicel colorless, about as long as the spore.

This short-cycle species differs from *Puccinia Arenariae* (Schum.) Wint. especially in the pale and very thin-walled spores.

55. PUCCINIA ARECHAVELATAE Speg. (on *Sapindaceae*)

Cardiospermum grandiflorum Sw., Alajuela, Jan. 7, 1916, 383.

A short-cycle rust, common throughout the American tropics.

56. PUCCINIA GOUANIAE Holw. (on *Frangulaceae*)

Gouania polygama (Jacq.) Urban (*G. tomentosa* Jacq.), San José, Dec. 26, 1915, II, 293A; Orotina, Dec. 31, 1915, II, 333.

A species having pycnia, primary and secondary uredinia, and telia. It occurs also in the West Indies, and in Panama.

57. PUCCINIA HETEROSPORA Berk. & Curt. (on *Malvaceae*)

Malvaviscus arboreus Cav., Cartago, Dec. 22, 1915, 276; San José, Jan. 10, 1916, 402.

A short-cycle rust, widely distributed in both North and South America on many hosts.

58. PUCCINIA ANODAE Syd. (on *Malvaceae*)

Anoda hastata Cav., Cartago, Dec. 14, 1915, 257.

The species is known from South America, but has not before been reported from North America. It was, however, collected by Prof. Holway in Mexico, on *Anoda acerifolia* Cav., intermixed with his no. 3194 of *P. heterospora*. It is a short-cycle rust, with cinnamon-brown sori and teliospores.

59. **Puccinia filopes** Arthur & Holway sp. nov. (on *Sterculiaceae*)

Buettneria carthaginensis Jacq., Orotina, Dec. 31, 1915, 337.

Telia chiefly hypophyllous, crowded or confluent in circular areas 2–5 mm. across on larger discolored spots, round, 0.1–0.3

mm. in diameter, early naked, pulvinate, golden-brown, becoming cinereous by germination, ruptured epidermis inconspicuous; teliospores oblong-obovoid, 13-16 by 30-40 μ , rounded above, somewhat narrowed below, slightly constricted at septum; wall pale golden-brown, sometimes lighter below, 1-1.5 μ thick, slightly or not thickened at apex; pedicel colorless, once to twice length of spore, slender, 7-9 μ in diameter next to spore, tapering downward.

A short-cycle rust, probably without pycnia, for which the type selected was collected by Professor Holway in Guatemala, on *Buettneria lateralis* Presl, at Escuintla, Feb. 17, 1916, 501.

60. PUCCINIA VIOLAE (Schum.) DC. (on *Violaceae*)

Viola nannei Polak, Volcán de Irazú, Cartago, Dec. 23, 1915, II, III, 289; El Alto near Cartago, Jan. 16, 1916, II, III, 433.

A widespread, long-cycle species, with aecia, much more abundant in temperate regions.

61. PUCCINIA FUCHSIAE Syd. & Holw. (on *Onagraceae*)

Lopezia hirsuta Jacq., Volcán de Irazú, Cartago, Dec. 23, 1915, 282; Tres Rios near San José, Jan. 17, 1916, 438.

A short-cycle rust found on the same host in Guatemala and extending to southern Mexico on *Fuchsia*.

62. PUCCINIA FUMOSA Holw. (on *Polemoniaceae*)

Loeselia sp., San José, Dec. 26, 1915, II, iii, without number.

A long-cycle rust with all spore forms, known from Mexico and Guatemala.

63. PUCCINIA HYDROCOTYLES (Link) Cooke (on *Ammiaceae*)

Hydrocotyle umbellata L., San José, Dec. 15, 1915, II, 259.

The species was also collected on *H. mexicana* Cham. & Schl., at San José, by A. Tonduz, August, 1908, showing uredinia.

It is a long-cycle rust whose initial stage is yet unknown, unless the form described by Spegazzini as *Aecidiolum Hydrocotyles* may belong here. It is common in the warmer parts of America, and less common in other parts of the world.

64. *PUCCINIA CRASSIPES* Berk. & Curt. (on *Convolvulaceae*)
Ipomoea purga Hayne, Orotina, Dec. 30, 1915, I, III, 325; San José, Jan. 8, 1916, I, 392; Heredia, Jan. 23, 1916, I, 456.

The rust was also collected at a small railway station about fifty miles west of Limón, on *I. trifida* (H.B.K.) G. Don, by E. Bethel, March, 1913, showing aecia only. The species is common in tropical America.

65. *PUCCINIA LANTANAE* Farl. (on *Verbenaceae*)

Lantana Camara L., San José, Dec. 27, 1915, 303; same, Jan. 3, 1916, 352.

Lantana hispida H.B.K., San José, Dec. 10, 1915, 244; Cartago, Dec. 22, 1915, 278.

Lantana sp., Orotina, Dec. 31, 1915, 338.

A short-cycle rust common in the warmer parts of America.

66. *Puccinia elatipes* Arthur & Holway sp. nov. (on *Verbenaceae*)

Lippia sp., hills southwest of San José, Dec. 27, 1915, II, III, 307.

Pycnia epiphyllous, few, crowded on discolored spots, 1-1.5 mm. across, conspicuous, subepidermal, cinnamon-brown or darker, flattened conical, 190-238 μ broad by 74-144 μ high.

Uredinia amphigenous, crowded on spots with the pycnia, round or oval, 0.2-0.4 mm. across, early naked, pulverulent, cinnamon-brown, ruptured epidermis inconspicuous; urediniospores obovoid, usually flattened above and on the pore-bearing sides, so that when seen with pores in optical section appearing obovoid-triangular, 23-25 by 26-29 μ in obovoid view, and 26-29 by 26-29 μ in triangular view; wall cinnamon-brown, 1.5 μ thick, rather sparsely and strongly echinulate, the pores 2, approximately equatorial.

Telia hypophyllous or somewhat amphigenous, scattered, round, 0.1-0.5 mm. across, early naked, pulvinate, chestnut-brown, ruptured epidermis inconspicuous; teliospores ellipsoid, 23-26 by 39-42 μ , rounded at both ends, moderately constricted at the septum; wall cinnamon-brown, thin, 1 μ , thickened by a colorless umbo at the apex, 3-4 μ , smooth; pedicel colorless, cylindric or fusiform-cylindric, 18-24 by 100-150 μ , the wall thin.

The species is especially characterized by flattened urediniospores and by exceedingly large and inflated pedicels to the teliospores. The type was collected by Professor Holway in Guatemala on *Lippia myriocephala* Schl. & Cham., on the road between Quezaltenango and Colomba, Feb. 4, 1917, O, ii, III, 831. The host of the Costa Rican collection resembles *L. umbellata* Cav.

67. *PUCCINIA URBANIANA* P. Henn. (on *Verbenaceae*)

Valerianodes cayennensis (Vahl) Kuntze (*Stachytarpheta cayennensis* Vahl), Orotina, Dec. 31, 1915, 335.

A short-cycle rust, very common in tropical America on many hosts.

68. *Puccinia permagna* Arthur & Holway sp. nov. (on *Verbenaceae*)

Lippia myriocephala Schl. & Cham., San José, Jan. 10, 1916, 404.

Pycnia epiphyllous, loosely grouped on yellowish spots 0.4–1.5 mm. across, noticeable, blackish-brown, subepidermal, conoidal, 112–128 μ broad, 55–80 μ high; ostiolar filaments wanting.

Telia mostly hypophyllous, numerous, single or crowded into irregular groups, roundish, large, 1–2.5 mm. across, somewhat pulvinate, cinnamon-brown, ruptured epidermis inconspicuous; teliospores broadly ellipsoid, 24–27 by 35–42 μ , rounded at both ends, slightly constricted at septum; wall cinnamon-brown, thin, 1 μ , thicker above and over pore near septum, 3–6 μ , forming a hyaline umbo, smooth; pedicel very large and inflated, 20–25 μ in diameter, often somewhat fusiform, four to five times length of spore, the wall colorless, thin, 1 μ , usually thickened next the spore.

The species has a general resemblance to *P. elatipes* Arth. & Holw., which occurs on the same host in Guatemala, but is without uredinia. The pycnia are remarkably numerous and conspicuous, being much darker than in *P. elatipes*. The telial sori are also larger than in that species, as are the teliospores and especially their pedicels.

The fungus was found only on fresh shoots coming up from stumps of the shrubs cut to make the trail. The growth was very

luxuriant and the leaves much larger than on shoots of slower growth. Such preference seems to be common for rusts on shrubs and trees.

69. *PUCCINIA MITRATA* Sydow (on *Lamiaceae*)

Salvia polystachya Ort., San José, Jan. 3, 1916, ii, III, 348.

The species occurs also in Guatemala and southern Mexico. The present collection, the only one known from Costa Rica, has the characteristic, thick-walled teliospores of the species, which is a close relative of *P. farinacea*. The beginning stages in the life cycle are not known.

70. *Puccinia impedita* Mains & Holway sp. nov. (on *Lamiaceae*)

Salvia hypnoidis Mart. & Gal., Heredia, Dec. 17, 1915, II, 264;
San José, Dec. 26, 1915, II, III, 297 (type); Orotina, Dec.
31, 1915, II, 340.

Salvia occidentalis Sw., Orotina, Dec. 30, 1915, II, 326.

Salvia tiliaefolia Vahl, Tres Rios near San José, Jan. 17, 1916,
II, iii, 441.

Uredinia hypophyllous, scattered, round, 0.1–0.5 mm. across, early naked, pulverulent, cinnamon-brown, ruptured epidermis evident; urediniospores oblate-sphaeroid, 18–23 μ broad by 16–19 μ long, or globoid, 16–23 μ in diameter; wall cinnamon-brown, 1–1.5 μ thick, moderately echinulate, the pores 2–3, approximately equatorial or slightly subequatorial.

Telia hypophyllous or cauliculous, scattered, on the leaves round, 0.2–0.4 mm. in diameter, on the stems crowded or coalescent, 2–12 mm. in length, early naked, pulvinate at first, becoming pulverulent, blackish-brown, ruptured epidermis inconspicuous; teliospores broadly ellipsoid, 24–32 by 30–50 μ , rounded at both ends, not constricted at septum; wall dark chestnut-brown, thick, 3–5 μ , thicker over germ pore as a yellowish umbo, 5–9 μ , very finely and inconspicuously verrucose; pedicel long, two to three times length of spore, the wall usually firm and thick, 1.5–2.5 μ .

The species is related to *P. salviicola* Diet. & Holw., where it has heretofore been listed, but which is now believed to be a more northern form, not reaching to Central America. It also resembles *P. caulicola* Tracy & Gall., but the teliospores are con-

siderably broader and more nearly ellipsoid than in that species. Uredinia associated with pycnia were found on a collection from Porto Rico on *Salvia coccinea*, appearing like this species, but no teliospores were present to make the determination certain. The diagnoses for this and the following species were drawn up by E. B. Mains.

71. **Puccinia diutina** Mains & Holway sp. nov. (on *Lamiaceae*)
Salvia Pittieri Briq. (?), slopes of Volcán de Irazú above Cartago, Dec. 23, 1915, O, I, II, III, 290.

Pycnia epiphyllous, few, noticeable, light brown, subepidermal, globoid, 100–190 μ in diameter.

Aecia hypophyllous, crowded on yellowish spots opposite the pycnia; peridium white, the margin erose; peridial cells irregularly rectangular in longitudinal section, 13–20 by 26–50 μ , abutted or slightly overlapping, the outer wall 5–13 μ thick, striate, the inner wall 1.5 μ , closely and finely verrucose; aeciospores ellipsoid or globoid, 19–26 by 27–39 μ ; wall colorless, thick, 2.5–5 μ , very finely and closely verrucose.

Uredinia amphigenous, scattered, round, small, 0.1–0.2 mm. in diameter, early naked, pulverulent, dark cinnamon- or chestnut-brown, the ruptured epidermis rather inconspicuous; urediniospores oblate-spheroid or globoid, 19–24 μ in diameter; wall dark chestnut- or light cinnamon-brown above, 2 μ thick, becoming rather abruptly colorless and less than 1 μ thick below, closely and finely echinulate, the pores indistinct.

Telia amphigenous, scattered, round, 0.1–0.2 mm. across, early naked, somewhat pulverulent, blackish-brown, ruptured epidermis rather inconspicuous; teliospores broadly ellipsoid, 23–26 by 25–33 μ , rounded at both ends, slightly or not constricted at septum; wall dark chestnut-brown, 2–3 μ thick, occasionally thickened up to 5 μ above, rather closely and coarsely verrucose; pedicel colorless, fragile, once to twice length of spore, sometimes attached laterally.

The same species was also collected by Prof. Holway in Mexico on *Salvia scorodoniaefolia* Poir., at Chapala, Sept. 24, 1899, II, iii, 3493, and at Oaxaca, Oct. 21, 1899, II, III, 3698. In its teliospores it resembles *P. badia* somewhat, but in the other two spore forms the species is markedly distinct.

72. PUCCINIA HYPTIDIS (Curt.) Tracy & Earle (on *Lamiaceae*)
Hyptis capitata (L.) Jacq., San Ramón, Jan. 13, 1916, II, 419.

A common rust of Mexico, West Indies, and the southern United States.

73. PUCCINIA HYPTIDIS-MUTABILIS Mayor (on *Lamiaceae*)
Hyptis polystachya H.B.K., Heredia, Dec. 17, 1915, I, II, III, 269; Orotina, Jan. 1, 1916, I, II, iii, 346; San José, Jan. 10, 1916, II, 405.

This species is now first reported from North America. It was described from material collected in Colombia, S. A., only uredinia and telia being present. The Costa Rican material shows aecia, as well as the other forms, which may be thus characterized.

Aecia amphigenous, in crowded groups, 1–2.5 mm. across, round or nearly so, 0.2–0.5 mm. in diameter; peridium very fragile and evanescent, frequently less conspicuous than the ruptured epidermis; peridial cells irregularly cylindric, overlapping, the outer wall sometimes tinted, about 3μ thick, smooth, the inner wall $3\text{--}4\mu$ thick, conspicuously verrucose; aeciospores ellipsoid or ovoid, 16–19 by $21\text{--}30\mu$; wall light yellow, $1.5\text{--}2\mu$ thick, closely and noticeably verrucose.

74. PUCCINIA FIDELIS Arth. (on *Lamiaceae*)
Hyptis lilacina Schiede & Deppe, San José, Dec. 10, 1915, I, II, iii, 245.

The species occurs on the same host also in Guatemala.

75. PUCCINIA MEDELLINENSIS Mayor (on *Lamiaceae*)
Hyptis pectinata Poir., San José, Dec. 26, 1915, I, II, III, 297½.
Hyptis polystachya H.B.K., road to Volcán de Poás, Jan. 5, 1916, II, 373.
Hyptis suaveolens Poir., Orotina, Dec. 29, 1915, II, 313.
Hyptis sp., Orotina, Dec. 30, 1915, I, II, iii, 331.

A common long-cycle rust in tropical America.

76. PUCCINIA SARACHAE Mayor (on *Solanaceae*)
Sarache jaltomata Schlecht., Volcán de Irazú, Cartago, Dec. 23, 1915, 282½, 283.

A short-cycle species, described from South America, and now reported for the first time from North America. The host is the *yerba mora*, common in the gardens of Costa Rica, and grown for its edible fruit. The plant much resembles large forms of *Solanum nigrum*.

77. PUCCINIA PITTIERIANA P. Henn. (on *Solanaceae*)

Solanum tuberosum L., Volcán de Irazú, 10,000 feet alt., Cartago, Jan. 21, 1916, 455.

This short-cycle species, the only rust known on the common field potato, was first collected by H. Pittier, on Volcán de Irazú, September, 1903, and again at La Canada, probably at or near the original locality, in October 1904. It has not yet been reported outside the type vicinity.

78. PUCCINIA ACNISTI Arth. (on *Solanaceae*)

Acnistus arborescens Schl., San José, Dec. 10, 1915, I, 240; Heredia, Dec. 17, 1915, O, I, 266; road to Fraijanes, Volcán de Poás, Jan. 6, 1916, I, 376; Cartago, Jan. 20, 1916, I, 449.

A long-cycle species, having pycnia, aecia and telia, now first reported for North America. The type material came from the mountains of Peru, and on the same host.

79. *Puccinia nesodes* Arthur & Holway sp. nov. (on *Scrophulariaceae*)

Lamourouxia Gutierrezii Oerst., road to Fraijanes, Volcán de Poás, Jan. 6, 1916, 379; San José, Jan. 11, 1916, 411.

Lamourouxia viscosa H.B.K., Tres Rios near San José, Dec. 20, 1915, 275 (type).

Telia chiefly hypophyllous, more or less confluent in circular groups 1-6 mm. across, round, 0.1-0.5 mm. in diameter, early naked, pulvinate, chestnut-brown, becoming cinereous by germination, ruptured epidermis inconspicuous; teliospores obovoid or ellipsoid, 13-19 by 26-39 μ , rounded above, rounded or narrowed below, slightly constricted at septum; wall cinnamon-brown, thin, 1-2 μ , thicker above, 3-7 μ , smooth; pedicel colorless, once or twice length of spore.

This short-cycle species has resemblances to others on the

same family of plants, none of which, however, extends into Central America. It has smaller spores with less apical thickening than *P. mexicana* D. & H. on *Pentstemon*. In spore measurements it is like the northern *P. Synthryidis* E. & E., on *Synthryis*, but has darker and more crowded sori, while from *P. Seymeriae* Burr., on *Gerardia* and *Dasystoma* it is distinguished by darker and thicker-walled spores. The same species occurs in Guatemala on *Castilleja*.

80. *Puccinia depallens* Arthur & Holway sp. nov. (on
Bignoniaceae)

Pithocotenum muricatum DC. (?), road to Volcán de Poás, Jan. 5, 1916, O, III, 365.

Pycnia epiphyllous, gregarious on discolored areas 2-3 mm. across, light brown becoming dark brown, conspicuous, subcuticular, lenticular or low conic, 128-160 μ in diameter, 48-77 μ high; ostiolar filaments wanting; pycniospores ellipsoid, colorless, 2.5 by 3-4 μ .

Telia hypophyllous, crowded in circles on spots opposite the pycnia, early naked, oval, 0.2-0.4 mm. long, compact, light cinnamon-brown or cinereous from the germinating spores, ruptured epidermis inconspicuous; teliospores terete, large, 16-27 by 45-96 μ , obtuse or rounded at both ends, slightly or not constricted at the septum, which is more or less oblique; wall colorless or slightly tinted, uniformly thin, 1 μ , smooth; pedicel half to nearly as long as the spore, colorless, firm, broad, thin-walled.

A short-cycle rust with quite or nearly colorless teliospores, that germinate at maturity. It occurs also in Guatemala on the same host.

81. PUCCINIA RUELLIAE (B. & Br.) Lagerh. (on *Acanthaceae*)

Blechnum Brownei (Sw.) Juss., San José, Jan. 17, 1916, II, 347.

Justicia sp., Orotina, Dec. 29, 1915, II, 316; Cartago, Jan. 20, 1916, I, 447.

A long-cycle rust, cosmopolitan in milder climates, extending northward to the next to last tier of states before reaching the Canadian line in the Mississippi valley. The form on *Blechnum* with which teliospores have only been found in Cuba and Ecuador, is usually listed under the name *P. Blechi* Lagerh., and forms

on other hosts are quite commonly given under *P. lateripes* Berk. & Rav. Considerable variation exists in the size of the spores, generally influenced by the succulency of the host.

82. PUCCINIA ELYTRARIAE P. Henn. (on *Acanthaceae*)

Tubiflora squamosa (Jacq.) Kuntze (*Elytraria squamosa* Lind.),
Orotina, Dec. 29, 1915, 312.

A short-cycle rust occurring also in Mexico and Guatemala, as well as in South America.

83. PUCCINIA LATERITIA Berk. & Curt. (on *Rubiaceae*)

Borreria ocymoides (Burm.) DC., San José, Dec. 11, 1915, 250;
same, Dec. 26, 1915, 299.

Coccocypselum hirsutum Bartl., hills southwest of Cartago, Dec.
22, 1915, 279.

A common short-cycle rust, found on many hosts. The second host named is new for the species.

84. PUCCINIA PUNCTATA Link (on *Rubiaceae*)

Galium uncinatum DC., slopes of Volcán de Irazú above Cartago,
Dec. 23, 1915, II, 284.

A common long-cycle rust, especially well developed in temperate regions.

85. PUCCINIA ROTUNDATA Diet. (on *Carduaceae*)

Vernonia patens H.B.K., Orotina, Jan. 1, 1916, O, III, 343.

A short-cycle rust described from South America and now first reported from North America.

86. PUCCINIA DISCRETA Jacks. & Holw. (on *Carduaceae*)

Vernonia Deppeana Less., San José, Dec. 15, 1915, O, III, 260;
same, Dec. 27, 1915, O, III, 305; same, Jan. 3, 1916, III,
363; same, Jan. 10, 1916, III, 406.

A short-cycle form found also in Guatemala, although the type of the species is no. 260, cited above. It is a microform, usually occurring on the leaves of terminal shoots from young plants.

87. PUCCINIA ARTHURIANA Jackson (on *Carduaceae*)

Vernonia canescens H.B.K., Volcán de Irazú, Cartago, Dec. 24, 1915, II, III, 281; San José, Jan. 3, 1916, O. II, III, 360.

The species is a long-cycle one, without aecia of the aecidioid form, and heretofore has only been known from the West Indies. It was published in the North American Flora (7:218. 1912) under the name *Argomyces Vernoniae* Arth., and so listed in the two reports on the Uredinales of Porto Rico (Mycol. 7:180. 1915; and 9:67. 1917), but in order to be uniform in placing white-spored forms under the genus *Puccinia*, it has been given another name in recent studies made by Jackson, as that of *P. Vernoniae* Schw., was already in use for another species.

88. PUCCINIA PRAEALTA Jacks. & Holw. (on *Carduaceae*)

Vernonia triflosculosa H.B.K., Heredia, Dec. 17, 1915, II, 262; San José, Jan. 10, 1916, II, III, 407; San Ramón, Jan. 13, 1916, II, 426.

A long-cycle species, whose initial stage is not known. It occurs also in Guatemala on the same host. The sori are deep seated and strictly epiphyllous.

89. PUCCINIA IDONEA Jacks. & Holw. (on *Carduaceae*)

Vernonia triflosculosa H.B.K., San José, Jan. 8, 1916, II, III, 398; same, Jan. 18, 1916, III, 445.

The sori of this species, which occurs also in Guatemala, are chiefly hypophyllous. Aecia are not yet known.

90. PUCCINIA PAUPERULA Arth. (on *Carduaceae*)

Elephantopus spicatus Juss., San José, Jan. 3, 1916, 353.

A short-cycle species occurring also in Mexico and Guatemala. It was collected on the same host at San Francisco de Guadalupe, by A. Tonduz, July, 1908. This collection was made the basis of a new name, *P. Elephantopodis-spicati* Pat., and a part of the type material was kindly transmitted for study by the author of it, N. Patouillard. It is found to be identical with the older named species.

91. PUCCINIA CONOCLINI Seym. (on *Carduaceae*)

Eupatorium pycnocephalum Less., San José, Jan. 11, 1916, II, III, 409.

Eupatorium Sinclairi Benth., Heredia, Dec. 17, 1915, II, 263; Orotina, Dec. 30, 1915, II, 329; trail to Volcán de Poás, Jan. 5, 1916, II, III, 375.

A widespread species of tropical and temperate North America, whose initial stage is unknown.

92. *Puccinia inermis* Jackson & Holway sp. nov. (on *Carduaceae*)

Eupatorium sp., El Alto near Cartago, Jan. 16, 1916, II, iii, 434A.

Uredinia hypophyllous, few, scattered, round, small, 0.2–0.4 mm. in diameter, early naked, dark cinnamon-brown, pulverulent, ruptured epidermis conspicuous; urediniospores greatly compressed laterally, somewhat flattened beneath, appearing somewhat reniform seen from the side with pores in optical section, 30–34 μ in greatest breadth from pore to pore, 24–26 μ broad at right angles, 23–26 μ long from hilum to apex; wall cinnamon-brown, 1–1.5 μ thick, finely and moderately echinulate, the pores 2, equatorial at the broadest part.

Telia in the uredinia broadly ellipsoid, 24–26 by 31–37 μ , rounded at both ends, somewhat constricted at septum; wall chestnut-brown, uniformly 1.5–2 μ thick, the pore of lower cell usually about half way between septum and pedicel; pedicel colorless, as long as spore, fragile, usually broken off near the spore.

The general characters of both the urediniospores and teliospores are similar to those of the two Mexican species on *Eupatorium*, *P. inanipes* and *P. espinosarum*, but not identical.

93. PUCCINIA SPEGAZZINII DeT. (on *Carduaceae*)

Mikania scandens (L.) Willd., Orotina, Dec. 30, 1915, 330; San José, Jan. 8, 1916, 394.

A common, short-cycle species of tropical America.

94. PUCCINIA DOLORIS Speg. (on *Carduaceae*)

Erigeron sp., San José, Jan. 10, 1916, 401.

A short-cycle species described from Argentina, S. A., and now reported from North America for the first time.

95. PUCCINIA EXORNATA Arth. (on *Carduaceae*)

Baccharis rhexioides H.B.K., San Ramón, Jan. 13, 1916, II, III, 423.

A long-cycle species, having all spore forms, which occurs also in Guatemala.

96. PUCCINIA OAXACANA Diet. & Holw. (on *Carduaceae*)

Conyza asperifolia (Benth.) Benth. & Hook. f. (*Baccharis hirtella* DC.), San José, Dec. 10, 1915, I, ii, III, 253; same, Jan. 10, 1916, I, ii, III, 403; same, Jan. 18, 1916, I, ii, III, 446; road to Volcán de Poás, Jan. 5, 1916, II, III, 366.

A long-cycle rust with all spore forms, occurring also in Guatemala and Mexico.

97. PUCCINIA GYMNOLOMIAE Arth. (on *Carduaceae*)

Gymnolomia microcephala Less., San José, Dec. 27, 1915, II, III, 301.

A long-cycle species, extending northward into Mexico, but the initial stage is yet unknown.

98. PUCCINIA TITHONIAE Diet. & Holw. (on *Carduaceae*)

Tithonia rotundifolia (Mill.) Blake (*T. tagetiflora* Desf.), trail to Volcán de Poás, Jan. 5, 1916, II, III, 369; San Ramón, Jan. 13, 1916, II, III, 425.

A long-cycle rust of Mexico and Guatemala, whose initial stage is yet unknown.

99. PUCCINIA ABRUPTA Diet. & Holw. (on *Carduaceae*)

Viguiera silvatica Klatt, San Ramón, Jan. 13, 1916, II, 424.

A long-cycle species, very common in Mexico, whose initial stage is unknown. It extends into Texas and into the West Indies.

100. **Puccinia proba** Jackson & Holway sp. nov. (on *Carduaceae*)

Zexmenia frutescens villosa (Polak) Blake, San José, Dec. 11, 1915, II, III, 247; same, Jan. 3, 1916, II, III, 350, 351.

Zexmenia sp., Road to Fraijanes on Volcán de Poás, Jan. 6, 1916,
II, III, 377.

Pycnia epiphyllous, few, gregarious, noticeable, subepidermal, orange becoming brownish, globose or flask-shaped, 50–65 μ broad by 50–80 μ high.

Uredinia (primary) epiphyllous, crowded on slightly raised spots surrounding the pycnia, or (secondary) chiefly hypophyllous, scattered, round, small, 0.2–0.4 mm. in diameter, early naked, pulverulent, cinnamon-brown, ruptured epidermis, conspicuous; urediniospores obovoid or broadly ellipsoid, 16–19 by 20–24 μ ; wall colorless or light golden-yellow, 1–1.5 μ , finely and moderately echinulate, the pores 2, equatorial.

Telia chiefly hypophyllous, scattered, round, small, 0.2–0.4 mm. in diameter, early naked, pulvinate, chocolate-brown, becoming cinereous by germination, ruptured epidermis conspicuous; teliospores ellipsoid or obovate, 16–20 by 26–34 μ , rounded above, rounded or narrowed below, not or slightly constricted at septum; wall (in resting form) chocolate-brown, 2–3 μ thick, thicker above by a broad lighter colored umbo, 3–7 μ , uniformly and finely verrucose, or (in germinating form) cinnamon- or light chestnut-brown, 1–2 μ thick, obscurely verrucose above and smooth below; pedicel colorless, once to once and a half length of spore, often deciduous.

The species is a long-cycle one without aecia, and is well marked and especially characteristic in having teliospores that are dark and thick walled in some sori and light and thinner walled in others, the former being in resting condition and the latter germinating like a leptiform.

101. *Puccinia absicca* Jackson & Holway sp. nov. (on
Carduaceae)

Zexmenia frutescens villosa (Polak) Blake, San José, Dec. 10,
1915, O, III, 239.

Pycnia epiphyllous, few, gregarious, yellowish or light orange, conspicuous, subepidermal, globoid, 30–50 μ broad.

Telia epiphyllous, numerous in crowded, orbicular groups surrounding the pycnia, or in elongated groups on the veins, roundish, 0.5–0.8 mm. across, somewhat tardily naked, pulverulent, chestnut-brown, surrounding epidermis conspicuous; teliospores ellipsoid, 20–24 by 28–34 μ , rounded at both ends, not or slightly constricted at the septum; wall cinnamon- to chestnut-brown, 2–2.5 μ thick, thicker above, 5–7 μ , moderately verrucose-rugose, often

slightly striate, the pore of lower cell near the pedicel; pedicel short, fragile, colorless.

This appears to be the correlated short-cycle form for *Puccinia proba* Jacks. & Holw. Its spore structures are morphologically nearly or quite identical with those of that species.

102. PUCCINIA OYEDAEAE Mayor (on *Carduaceae*)

Oyedaea acuminata (Benth.) Benth. & Hook. f., Tres Rios near San José, Dec. 20, 1915, O, I, II, III, 274; San José, Jan. 3, 1916, O, I, II, 356.

The species was founded on a telial collection from Colombia, S. A., the host being an undetermined species of *Oyedaea*. It was classed as one of the Leptopuccinias. Prof. Holway's collections, the first for North America, supply all the other stages, which may be characterized as follows.

Pycnia epiphyllous, in small groups, chocolate-brown, conspicuous, subepidermal, globose, 112–128 μ in diameter.

Aecia epiphyllous, associated with the pycnia in groups 0.3–2 mm. across, cupulate; peridium white, erose; peridial cells linear oblong, 5–7 by 26–35 μ , abutted, the walls 1.5–2 μ thick; aeciospores broadly ellipsoid, 23–26 by 26–32 μ ; wall yellowish, 3 μ thick, thickening up to 4–7 μ at apex, closely tuberculate-verrucose.

Uredinia hypophyllous, scattered, round, 0.1–0.4 mm. across, early naked, pulverulent, dark cinnamon-brown, ruptured epidermis inconspicuous; urediniospores globose or broadly ellipsoid, 23–27 by 26–32 μ ; wall dark cinnamon-brown, thick, 2.5–3 μ , closely echinulate, the pores 6–10, scattered.

Excellent drawings of the long and narrow teliospores are given by Mayor (Mem. Soc. Neuch. Sci. Nat. 5:535. 1913). These are strongly thickened at the apex, and of a decided brown color, becoming nearly or quite colorless below.

103. PUCCINIA CALEAE Arth. (on *Carduaceae*)

Calea urticifolia (Mill.) DC., San José, Dec. 10, 1915, ii, III, 243; same, Jan. 3, 1916, III, 349; same, O, I, II, 357; Heredia, Dec. 17, 1915, II, III, 265; Orotina, Dec. 31, 1915, II, III, 339.

A long-cycle rust, occurring also in Guatemala and Mexico.

104. *PUCCINIA FEROX* Diet. & Holw. (on *Carduaceae*)
Verbesina myriocephala Sch. Bip., San Ramón, Jan. 13, 1916, III,
418.

A short-cycle rust, heretofore only known from Mexico.

105. *PUCCINIA TAGETICOLA* Diet. & Holw. (on *Carduaceae*)
Tagetes filifolia Lag., San José, Dec. 10, 1915, III, 242.
Tagetes microglossa Benth., San José, Dec. 10, 1915, II, 241.

A long-cycle rust, found in Mexico, the West Indies, and in South America, the initial stage being still unknown.

106. *PUCCINIA ABSINTHII* DC. (on *Carduaceae*)
Artemisia vulgaris L., in a garden near San José, Dec. 28, 1915,
II, 308.

A long-cycle rust, having pycnia, uredinia and telia, very common and widely distributed. It has not before been reported on this host from North America.

107. *PUCCINIA COGNATA* Syd. (on *Carduaceae*)
Verbesina turbacensis H.B.K., San Ramón, Jan. 13, 1916, II, 422.

As only uredinia are present, the reference to this species is somewhat uncertain, especially as the host has not before been recorded for it.

108. *ENDOPHYLLUM CIRCUMSCRIPTUM* (Schw.) W. & O. (on
Vitaceae)

Cissus sicyoides L.

A short-cycle species, very common in tropical America on various species of *Cissus*. It was collected at San José, on *C. sicyoides*, in 1911, by A. Tonduz, and a specimen communicated by N. Patouillard.

FORM-SPECIES BELONGING TO AECIDIACEAE

109. *Aecidium albicans* Arthur & Holway, sp. nov. (on
Euphorbiaceae)

Phyllanthus acuminatus Vahl, San José, Dec. 26, 1915, 294; *Orotina*, Dec. 30, 1915, 327 (type).

Pycnia hypophyllous, few, associated with small groups of aecia, subepidermal, ovoid, $24-48\mu$ broad by $48-67\mu$ high.

Aecia hypophyllous, rarely in small groups associated with pycnia, usually scattered by ones and twos without pycnia, short-cylindric, 0.1 mm. or less across, 0.1-0.3 mm. high; peridium white, the margin recurved, erose; peridial cells rhombic, 12-13 by $16-19\mu$, abutted, the walls evenly $1.5-3\mu$ thick, the outer one smooth, the inner one very finely verrucose; aeciospores angularly globoid or ellipsoid, 13-16 by $16-19\mu$; wall colorless, 1-1.5 μ thick, finely and closely verrucose.

Five species of *Aecidium* have previously been described on *Phyllanthus*, from all of which the present collection apparently differs in having the aecia conspicuously scattered. Microscopic comparison has been made with *A. detritum* P. Henn. from Uruguay, and *A. favaceum* Arth. from Porto Rico, both of which have much larger spores. The descriptions of *A. Phyllanthi* P. Henn. from New Guinea, *A. phyllanthinum* Syd. from Assam, and *A. luzoniense* P. Henn. from the Luzon, appears to be distinctive, and unlike any of the American forms.

110. *AECIDIUM TUBULOSUM* Pat. & Gaill. (on *Solanaceae*)

Solanum torvum Sw., Orotina, Dec. 31, 1915, 341.

A common aecial rust of the tropics on *Solanum torvum* and closely related hosts, which according to the observations of Whetzel and Olive in Porto Rico doubtless is one stage of the grass rust, *Puccinia substriata*.

111. *Aecidium tenerius* Arthur & Holway sp. nov. (on *Solanaceae*)

Acnistus arborescens Schlecht., San José, Jan. 3, 1916, 362.

Aecia hypophyllous, scattered or loosely grouped, round, 0.3-0.8 mm. across; peridium inconspicuous, usually hidden by the persistent epidermis, or evanescent; peridial cells long and narrow in side view, often becoming curved, 5-9 by $29-48\mu$, the outer and inner walls quite thin, the inner very finely and inconspicuously verrucose; aeciospores globoid or ellipsoid, 19-23 by $24-32\mu$; wall colorless, 2-2.5 μ thick, frequently slightly thicker both above and below, inconspicuously verrucose, appearing smooth when wet.

The delicate peridium gives a very different appearance to this

rust than is presented by the aecia of *Puccinia Acnisti* Arth., found on the same host about in the same region. The habit also differs from *A. solanitum* Speg., which appears like a systemic form.

112. *AECIDIUM ABSCEDENS* Arth. (on *Rubiaceae*)

Randia aculeata L., San José, Dec. 15, 1915, 258.

This apparently heteroecious species has heretofore only been known from Porto Rico (Mycol. 7: 315. 1915).

113. *Aecidium ampliatus* Jackson & Holway sp. nov. (on *Carduaceae*)

Eupatorium sp., El Alto near Cartago, Jan. 16, 1916, 434.

Pycnia epiphyllous, gregarious, conspicuous, yellowish becoming orange, subepidermal, globose or flask-shaped, 80–100 μ broad; ostiolar filaments short.

Aecia hypophyllous, crowded on yellowish spots 2–8 mm. across, opposite the pycnia, cupulate; peridium strongly recurved, lacerate; peridial cells rhomboidal, 21–23 by 42–45 μ , considerably overlapping, the outer wall 2.5–3 μ thick, smooth, the inner wall 3.5–4.5 μ thick, prominently rugose-verrucose; aeciospores globose or broadly ellipsoid, 23–27 by 27–30 μ ; wall colorless, thin, 1 μ , very finely and closely verrucose.

It can not be predicted whether this form is the aecium of an autoecious or heteroecious species.

114. *Uredo Arundinellae* Arthur & Holway sp. nov. (on *Poaceae*)

Arundinella Deppeana Nees, San Ramón, Jan. 14, 1916, 431.

Uredinia hypophyllous, scattered, oval or oblong, minute, 0.1–0.3 mm. long, early naked, pulverulent, cinnamon-brown, ruptured epidermis evident; urediniospores broadly ellipsoid, globose or obovoid, 26–29 by 27–37 μ ; wall cinnamon-brown, thin, 1–1.5 μ , moderately echinulate, the pores usually 3, sometimes 2 or 4, equatorial.

Morphologically the species is similar to *P. Arundinariae*, but the urediniospores are somewhat larger, and with a much thinner wall. The pores are also more variable in number. As the hosts are only distantly related it is quite certain that the two rusts are only superficially associated.

115. *Uredo americana* (Mass.) comb. nov. (on *Orchidaceae*)
Cattleya Dowiana Bat.

This rust occurred on plants brought to the Kew conservatories from Costa Rica. The record was made in the Kew Bulletin for 1906, page 40, where it says that "only a small patch of rust was present on one leaf when the plant was received from Costa Rica, but this has continued to increase in size, and the falling spores have also inoculated other leaves." Upon application to the Kew Herbarium, a generous portion of the specimen preserved there was sent me on Oct. 11, 1915. The specimen bears the date "1899." I was unable, however, to find any rust upon the part submitted.

The writer has already recorded (Science 40:935. 1914) his belief that the assignment of this and similar Orchidaceous rusts to the genus *Hemileia* is not well founded. The opinion is shared with other uredinologists (Sydow, Monog. Ured. 3:221. 1914) that the description of teliospores made by Massee applies rather to over-mature urediniospores. The distinctive characters of the genus *Hemileia* of agglutinated pedicels and one-sided, dorsi-ventral urediniospores, the ventral side being smooth, are lacking among these orchid rusts. Moreover, it is difficult to believe that families of hosts so widely separated as the monocotyledonous *Orchidaceae* and the dicotyledonous *Rubiaceae* would bear closely related species of rusts of a restricted generic form. For these reasons this rust, which has heretofore been called *Hemileia americana* Mass. (Gard. Chron. III. 38:153. 1905) is transferred to the genus *Uredo*.

There are reasons for believing that Orchidaceous rusts of this character are to be associated with certain rusts of the Polypodiaceae, represented by *Uredo superficialis* (Speg.) DeT., and *U. Gymnogrammes* P. Henn. They have the same peculiar formation of uredinia, the sori being tufted hyphae protruding through the stomata, and are likely to divulge the same general characteristics of the teliospore. Teliospores of the fern rusts have been found which are of the general *Puccinia*-form. Massee's view that the teliospores of the orchid rusts are of the *Uromyces*-form can safely be ignored. If these characters can be fully

established by further collections and study, the two groups of rusts should be given independent generic rank.

116. *UREDO MACULANS* Pat. & Gaill. (on *Amaranthaceae*)
Achyranthes sp., Alajuela, Jan. 7, 1916, 382.

This is the first record of the species for North America. It has recently been collected in Panama, however, on *A. Williamsii* Standley, March 6, 1913, by E. Bethel. The species was originally described from Venezuela (Bull. Soc. Myc. Fr. 4:98. 1888), and is also known from Ecuador.

117. *UREDO HAMELIAE* Arth. (on *Rubiaceae*)
Hamelia erecta Jacq., San José, Jan. 8, 1916, 390.

Heretofore the species has only been known from two collections from Porto Rico (Mycol. 8:23. 1916; and 9:95. 1917).

118. *Uredo suspecta* Jackson & Holway sp. nov. (on *Carduaceae*)
Eupatorium daleoides (DC.) Hemsl. (?), Cartago, Jan. 20, 1916, 448.

Uredinia hypophyllous, few, gregarious or scattered, dark cinnamon-brown, ruptured epidermis conspicuous; urediniospores ellipsoid or obovoid, 26–29 by 30–35 μ ; wall dark cinnamon-brown, 2–2.5 μ thick, echinulate, the pores 2, equatorial.

This uredinial form doubtless belongs to some species of *Puccinia*. It is much like *P. Clinopodii*, but has much larger spores with thicker walls. No telia on a smooth-leaved *Eupatorium* similar to the host in hand, which could belong with such a form, have yet been seen.

INDEX TO UREDINALES

New or newly combined names are in **bold-faced** type

Aecidiolum Hydrocotyles, 63

Aecidium abscedens, 112

albicans, 109

ampliatum, 113

crotalariicola, 31

detritum, 109

favaceum, 109

luzoniense, 109

Phyllanthi, 109

phyllanthinum, 109

Aecidium solanitum, 111

tenerius, 111

tubulosum, 110

Alveolaria Cordiae, 15

Argomyces Vernoniae, 87

Calliospora Diphysae, 20

Cerotelium Fici, 7

Chrysocelis Lupini, 6

Cionothrix praelonga, 14

Coleosporium Elephantopodis, 3

- Coleosporium Eupatorii*, 4
 Ipomoeae, 1
 Verbesinae, 5
 Viburni, 2
Cronartium coleosporioides, 12
 Wilsonianum, 13
Endophyllum circumscriptum, 108
Hemileia americana, 115
Phakopsora Crotalariae, 31
 Vitis, 8
Prospodium Amphilophii, 22
 appendiculatum, 21
 Lippiae, 24
 tuberculatum, 23
Puccinia abrupta, 99
 absicca, 101
 Absinthii, 106
 Acnisti, 78, 111
 angustatoides, 51
 Anodae, 58
 Arechavelatae, 55
 Arenariae, 54
 Arthuriana, 87
 Arundinariae, 114
 badia, 71
 Blechi, 81
 Caleae, 103
 canaliculata, 50
 caulicola, 70
 Cenchri, 47
 Clinopodii, 118
 cognata, 107
 Conoclini, 91
 consobrina, 51
 crassipes, 64
 depallens, 80
 detonsa, 54
 discreta, 86
 diutina, 71
 dochmia, 46
 doloris, 94
 elatipes, 66, 68
 Elephantopodis-spicati, 90
 Elytrariae, 82
 espinosarum, 92
 exornata, 95
 farinacea, 69
 ferox, 104
 fidelis, 74
 filopes, 59
 Fuchsiae, 61
 fumosa, 62
 Gouaniae, 56
 Gymnolomiae, 97
 heterospora, 57, 58
 Hydrocotyles, 63
 Hyptidis, 72
 Hyptidis-mutabilis, 73
 idonea, 89
 impedita, 70
 inanipes, 92
 inanipes, 92
 inermis, 92
 Lantanae, 65
 lateripes, 81
 lateritia, 83
 medellinensis, 75
 mexicana, 79
 mitrata, 69
 nesodes, 79
 oaxacana, 96
 Oyedaeae, 102
 Pallor, 52
 paupercula, 90
 permagna, 68
 Pittieriana, 77
 Polygoni-amphibii, 53
 praealta, 88
 proba, 100, 101
 punctata, 84
 purpurea, 49
 rotundata, 85
 Ruelliae, 81
 salviicola, 70
 Sarachae, 76
 Seymeriae, 79
 Spegazzinii, 93
 substriata, 110
 Synthyridis, 79
 tageticola, 105
 Tithoniae, 98
 Urbaniana, 67
 venustula, 48
 Vernoniae, 87
 Violae, 60
Ravenelia echinata, 18

Ravenelia *ectypa*, 18
 Humphreyana, 19
 Ingae, 16
 Mimosae-albidae, 17
Sphenospora pallida, 25
Spirechina Loeseneriana, 10
 Pittieriana, 11
 Rubi, 9
Uredo americana, 115
 Arundinellae, 114
 Gymnogrammes, 115
 Hameliae, 117
 maculans, 116
 ochraceo-flavus, 11
 superficialis, 115
 suspecta, 118
 Theresae, 31
 venustula, 48
Uromyces appendiculatus, 29
 Bidentis, 43
 bidenticola, 42, 43, 44
 Celosiae, 28

Uromyces Cestri, 37
 Cestri var. *maculans*, 37
 cestricola, 37
 Cologaniae, 34
 columbianus, 41
 Commelinae, 27
 cucullatus, 45
 decoratus, 31
 Eragrostidis, 26
 guatemalensis, 33
 Hariotanus, 38
 Hellerianus, 39
 Indigoferae, 32
 maculans, 37
 marginatus, 36
 mexicanus, 30
 Montanoae, 44
 Myrsines, 36
 Pittierianus, 11
 pressus, 40
 proeminens, 35
 venustus, 37

HOST INDEX

Acanthaceae, 38, 81, 82
Achyranthes Williamsii, 116
Acnistus arborescens, 78, 111
Amaranthaceae, 28, 116
Amaryllidaceae, 52
Ammiaceae, 63
Andropogon brevifolius, 48
Anoda acerifolia, 58
 hastata, 58
Ardisia compressa, 36
Artemisia vulgaris, 106
Artocarpaceae, 7
Arundinella Deppeana, 114
Baccharis hirtella, 96
 rhexioides, 95
Bauhinia inermis, 33
Bidens tereticaulis antiguensis, 42
 sp. 43
Bignoniaceae, 21, 22, 80
Blechnum Brownei, 81
Bomaria acutifolia, 52
Borreria ocymoides, 83
Buettneria carthaginensis, 59
 lateralis, 59
Caesalpinaceae, 19

Calea urticifolia, 103
Calliandra gracilis, 18
Caprifoliaceae, 2
Cardiospermum grandiflorum, 55
Carduaceae, 3, 4, 5, 14, 40, 41, 42, 43,
 44, 45, 85, 86, 87, 88, 89, 90, 91, 92,
 93, 94, 95, 96, 97, 98, 99, 100, 101,
 102, 103, 104, 105, 106, 107, 113, 118
Caryophyllaceae, 54
Castilleja tenuiflora?, 12
Cattleya Dowiana, 115
Cayaponia attenuata, 39
Cenchrus echinatus, 47
Cestrum nocturnum, 37
Chamaesyce hypericifolia, 35
Cissus rhombifolia, 13
 sicyoides, 108
Coccocypselum hirsutum, 83
Cologania pulchella, 34
Commelina longicaulis, 27
 nudiflora, 27
Commelinaceae, 27
Convolvulaceae, 1, 64
Conyza asperifolia, 96
Cordia ferruginea, 15

- Crotalaria juncea*, 31
 vitellina, 31
Cucurbitaceae, 39
Cyperaceae, 50, 51
Cyperus ferax, 50
Desmodium uncinatum, 30
Dichromena radicans, 50
Diphysa robinoides, 20
Ehretiaceae, 15
Elephantopus hypomalacus, 3
 spicatus, 90
Elytraria squamosa, 82
Eragrostis limbata, 26
Erigeron sp., 94
Eupatorium collinum, 4
 daleoides, 14, 118
 odoratum, 14
 Oerstedianum, 4
 pycnocephalum, 91
 Sinclairi, 91
 sp., 92, 113
Euphorbiaceae, 35, 109
Fabaceae, 6, 20, 29, 30, 31, 32, 33, 34
Ficus sp., 7
Frangulaceae, 56
Galium uncinatum, 84
Gouania polygama, 56
 tomentosa, 56
Gymnolomia microcephala, 97
Hamelia erecta, 117
Hydrocotyle mexicana, 63
 umbellata, 63
Hyptis capitata, 72
 lilacina, 74
 pectinata, 75
 polystachya, 73, 75
 suaveolens, 75
Indigofera mucronata, 32
Inga leptopoda, 16
Ipomoea hederacea, 1
 purga, 1, 64
 trifida, 64
Iresine calea, 28
Justicia sp., 81
Lamiaceae, 69, 70, 71, 72, 73, 74, 75
Lamourouxia Gutierrezii, 79
 viscosa, 79
Lantana Camara, 23, 65
 hispidia, 65
Lippia myriocephala, 24, 66, 68
 umbellata, 66
Loeselia sp., 62
Lopezia hirsuta, 61
Lupinus Clarkei, 6
Malvaceae, 57, 58
Malvaviscus arboreus, 57
Meibomia uncinata, 30
Melanthera aspera, 41
Mikania scandens, 93
Mimosa albida, 17
Mimosaceae, 16, 17, 18
Montanoa dumicola, 44
 Pittieri, 44
Muhlenbergia tenella, 46
Myrsinaceae, 36
Onagraceae, 61
Orchidaceae, 115
Oyedaea acuminata, 102
Persicaria punctata, 53
Pharbitis hederacea, 1
Phaseolus truxillensis, 29
Phyllanthus acuminatus, 109
Pithecoctenium muricatum, 22, 80
Poaceae, 26, 46, 47, 48, 49, 114
Poinciana pulcherrima, 19
Polemoniaceae, 62
Polygonaceae, 53
Polygonum punctatum, 53
Randia aculeata, 112
Rosaceae, 9, 10, 11
Rubiaceae, 83, 84, 112, 117
Rubus adenotrichos, 11
 trichomallus, 9, 10
Rynchospora corymbosa, 51
 polyphylla, 51
Salvia coccinea, 70
 hyptoidis, 70
 occidentalis, 70
 Pittieri?, 71
 polystachya, 69
 scorodoniaefolia, 71
 tiliaefolia, 70
Sapindaceae, 55
Sarache jaltomata, 76
Scrophulariaceae, 12, 79
Smilaceae, 25
Smilax sp., 25
Solanaceae, 37, 76, 77, 78, 110, 111

- Solanum torvum*, 110
 tuberosum, 77
Sorghum sp., 49
Stachytarpheta cayennensis, 67
Stellaria ovata, 54
Stenolobium Stans, 21
Sterculiaceae, 59
Tagetes filifolia, 105
 microglossa, 105
Tecoma Stans, 21
Thysacanthus strictus, 38
Tithonia rotundifolia, 98
 tagetiflora, 98
Tubiflora squamosa, 82
Valerianodes cayennensis, 67
Verbenaceae, 23, 24, 65, 66, 67, 68
Verbesina myriocephala, 5, 104
 nicaraguensis, 5
 turbacensis, 107
Vernonia canescens, 87
 Deppeana, 40, 86
 patens, 85
 triflosculosa, 88, 89
Viburnum sp., 2
Viguiera silvatica, 99
Viola nannei, 60
Violaceae, 60
Vitaceae, 8, 13, 108
Vitis sp., 8
Zexmenia aurantiaca, 45
 frutescens villosa, 100, 101

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA.